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RESEARCH ARTICLE

ROLE OF COMPUTED TOMOGRAPHY IN ACETABULAR FRACTURES.

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Abstract

In the 21st century, use of automobiles have not only revolutionized transport system across the globe, but have changed the lifestyle of human beings. The chief drawback of this gift is increase in cases of accidents. Most of accidents associated with polytrauma involve pelvis. In pelvic injuries, acetabular fractures and fracture dislocations of hip joint are common. The radiological evaluation of hip and acetabulum has been revolutionized by development of computed tomography because of itsfine definition of sectional anatomy and accurate evaluation of pelvic trauma.The study included 30 polytrauma cases, attending theRadiodiagnosis Department of Rajindra Hospital Patiala**.**

Introduction:-

Acetabular fractures constitute between 20% and 25% of all pelvic fractures in adults. CT is the modalitity of choice for evaluating these injuries. Axial images should be performed with contiguous slices no thicker than 3mm. Saggital and coronal reconstructions and three dimensional images are often helpful to conceptualize the fracture pattern before surgery (2). CT is helpful in delineating the extent and configuration of fractures of the acetabulum as the acetabular fractures and fracture dislocations of the hip joint are frequently complex and routine radiographs do not easily demonstrate the precise pathological anatomy. Intraarticular bony fragments, joint space incongruity and femoral head fractures may also be revealed by CT examination(3). Inconventional radiography, inaddition to standard AP view of pelvis, 45 degree oblique view , iliac oblique view, inlet and outlet views are taken which provide only means whereby spatial relationship of bones of pelvic ring can be assessed(5). There is no significant difference between plain radiography and computed tomography in detection of fractures of the iliac wing, anterior pelvic column, posterior pelvic column and pubic rami. However computed tomography is more sensitive than plain radiography in detecting pelvic fractures involving sacrum, quadrilateral surface,acetabular roof,posterior acetabular lip and primary loose bone fragments (6). In present study, the significance of computed tomography in diagnostic evaluation and management of the pelvic trauma patients was assessed. The computed tomographic findings in diagnosis and management of acetabular fractures were also compared.

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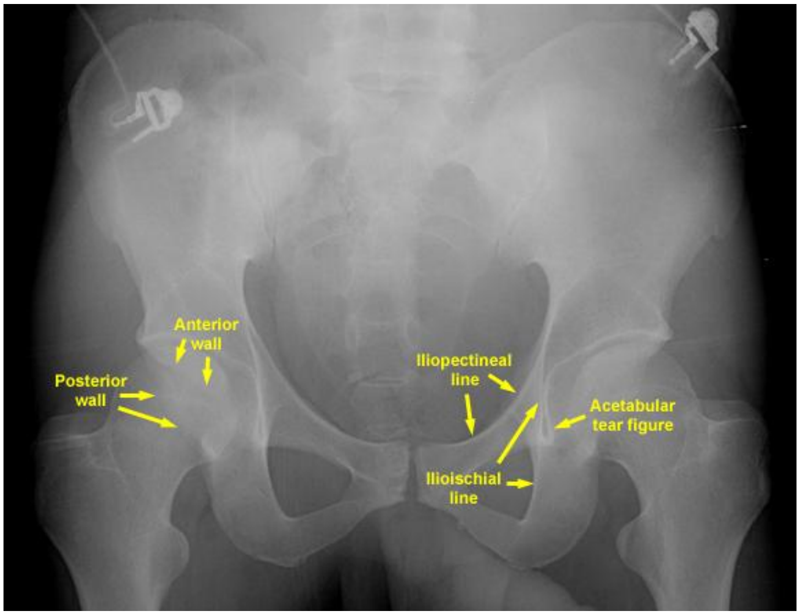

Figure 1:- Anteroposterior (AP) radiograph of the pelvis. The iliopectineal (or iliopubic) and ilioischial lines serve as landmarks for the anterior and posterior columns, respectively. The larger and more lateral posterior wall is visualized more easily than is the smaller, more medial anterior wall. The acetabular tear figure is a composite shadow of the inferomedial structures that compose the acetabulum. The ilioischial line should pass through the teardrop on a true AP view of the pelvis.

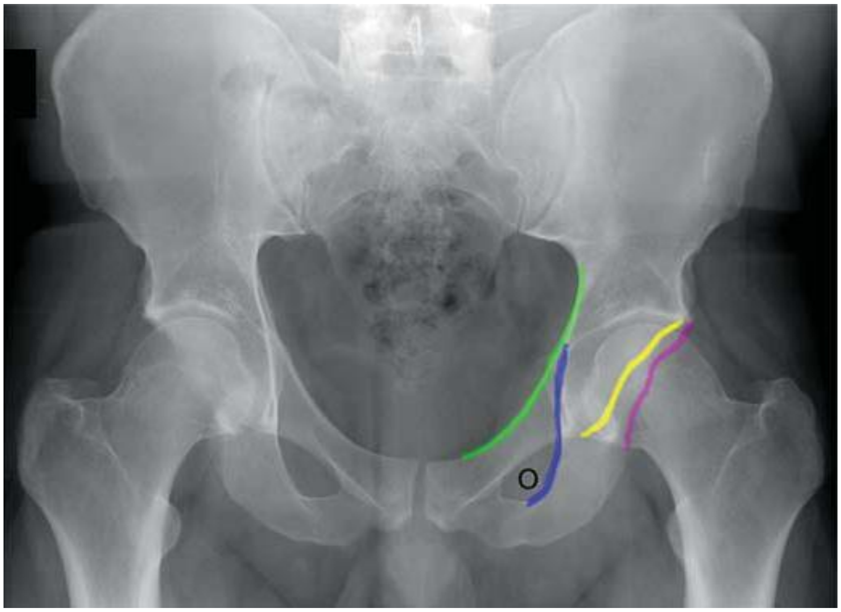

Figure 2:- Anteroposterior radiograph shows iliopectineal line (green), ilioischial line (blue), anterior acetabular wall (yellow), posterior acetabular wall (pink), and obturator foramen (O).

Classification Of Acetabular Fractures:-

The classification of acetabular fractures described by Letournel and Judet is most widely accepted (1,18). They divided acetabular fractures into two basic groups: elementary fractures and associated fractures.

Elementary Fractures comprise fractures in which a part or all of one columnof acetabulum has been detached. There are five elementary forms:-

1. Fractures of posterior wall of acetabulum
2. Fractures of posterior column of acetabulum
3. Fractures of anterior wall of acetabulum
4. Fractures of anterior column of acetabulum
5. Transverse Fracture

Posterior column and posterior wall fractures account for nearly 30% of all acetabular fractures, most common and are often as a result of posterior hip dislocation.

Anterior column and anterior wall fractures account for 6 to 7% of acetabular fractures, result in a separation of thearticular surfacetogether with the corresponding segment of iliopectineal line and mostly a fragment of anterior column is separated from rest of the innominate bone.

Transverse Fractures:-
Account for 8% to 10%of acetabular fractures, are axially oriented, separate the innominate bone into superior and inferior fragments usually at the level of acetabular roof.They are often associated with central fracture dislocation.

Associated Fractures:-
Include atleast two of the elementary fracture forms from above. There are five principal associations.

1. T-shaped fractures.
2. Fractures of the posterior column and posterior wall.
3. Transverse and posterior wall fractures.
4. Fractures of anterior column or anterior wall associated with a hemi transverse fracture posteriorly.
5. Fracture of both the columns.

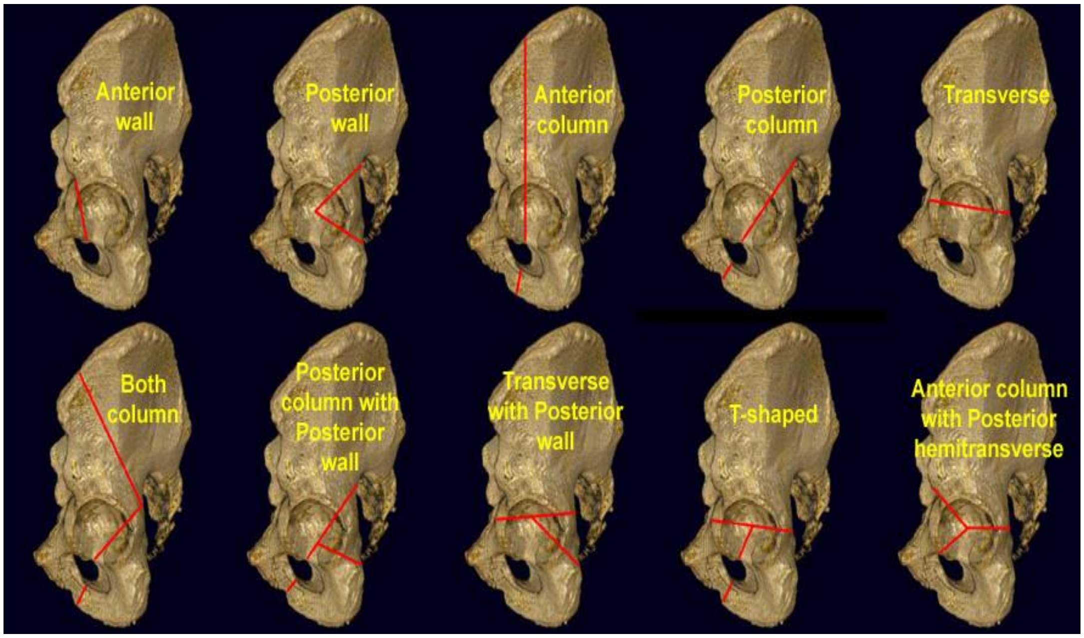

Figure 3:- Acetabular fracture classification system. Judet and colleagues (1964) described the classification scheme that is most commonly used today. Of the 10 types, 5 are elementary fractures (top row), and 5 are associated fractures (bottom row). Elementary types involve 1 primary fracture plane. Associated types involve more than 1 fracture plane

Materials and Methods:-

Study Design:-
Hospital based prospective correlative and comparative study. Source of data: 30 patients with clinically suspected or known hip fractures referred to department of Radiodiagnosis, Rajindra Hospital Patiala.

Protocol:-
A detailed history regarding mode of trauma and other sites of injuries besides pelvis were noted.Basic haematological investigations- Hb, TLC, DLCand other biochemical investigations like renal function tests, liver function tests were done if indicated. Conventional radiographic evaluation was done which included Antero-posterior views of pelvis including the area extending from iliac crest to the lesser trochanter of femur including both hip joints and sacroiliac joints. Oblique –lateral views of injured hip were done specially in cases in which dislocation of femoral head was suspected or evident on AP view. The plain radiographs were studied in detail and fracture lines were traced. Observations were recorded in the performa in all the cases. CT examination was done after initial radiographic

CT protocol:-
Patients were scanned with High Resolution Siemens Somatom Emotion, in supine position with 6mm to 8mm sections. 3D reconstructions were done from axial images using surface imaging technique in cases asked by the Orthopaedician, especially in patients with comminuted fractures. Clinical and imaging findings were recorded as per performa.

Radiographic AnatomyOf Acetabulum:-
Computed tomography has revolutionized diagnostic imaging of acetabular trauma as the three dimensional pictures of the fracture are vital for the diagnosis and treatment of these injuries. Crucial to interpretation of the axial computed tomography is an understanding of the normal cross sectional anatomy of acetabulum. The acetabulum can be described as an incomplete hemispherical socket with an inverted horseshoe shaped articular surface surrounding the non articular cotyloid fossa. The acetabulum is formed by anterior and posterior columns of bone which join in superior acetabular region (1,8,9). The anterior and posterior walls extend from each respective column and connect to axial Skeleton through a strut of bone called sciatic buttress. The anterior column represents larger portion which extends superiorly from superior pubic ramus into iliac wing. The posterior column extends superiorly from ischiopubhic rami as ischium towards ilium. The anterior and posterior column of bone will unite to support the acetabulum. In turn sciatic buttress extends posteriorly from anterior and posterior column to become articular surface of sacroiliac joint which attaches column to axial skeleton. On radiograph,iliopectineal line represents border of anterior column and ilioischial line represents posterior column. The fractures which traverse the anterior column disrupt the iliopectineal line, whereas fractures which traverse the posterior column disrupt ilioischial line. The column concept is used in classification of these fractures and is central to the discussion of fracture patterns, operative approaches and internal fixation.

Observations:-

Distribution of patients according to age:-
The maximum number of patients were in the age group of 20-40 yrs. Only three patients included in the study were above 60 years of age

Distribution of patients according to sex:-
Males were seen to be frequently involved in pelvic trauma as compared to females. Males were 83.3%. Only five females (16.7%) were seen in the study.

Mode of injury:-
The patients who sustained pelvic trauma due to roadside accident were 28 patients (93.3%). Only 2 patients (96.7%) had a positive history of fall from the height leading to pelvic injury.

Acetabular fractures detected on pelvic skiagram:-
In 26 patients (86.7%), definite acetabular fractures were seen, however in 13.3% of cases, no obvious fracture of acetabulum was detected on pelvic skiagrams.

Pattern of acetabular fractures detected on pelvic skiagramsview:-AP

Out of total 30 cases, comminuted fracture of acetabulum was seen in 16 patients (53%), whereas linear fracture was noted in 10 patients (34%). In 04 patients, definite fracture line was not seen on X rays, however there was high index of suspicion on account of associated fractures of pelvic bones.

Dislocation of femoral head detected on pelvic skiagram AP view:-

Dislocation of femoral head was seen in 14 cases (46.6%), whereas in the remaining (53.3%) patients, no associated dislocation of femoral head was seen.

Disribution of acetabular fractures on pelvic skiagrams:-

Most common acetabular fractures in our study were those in the roof, anterior and posterior column seen in 08 patients (31%). Posterior wall fracture was seen in 08 patients. Fracture of quadrilateral plate was seen in 03 patients.

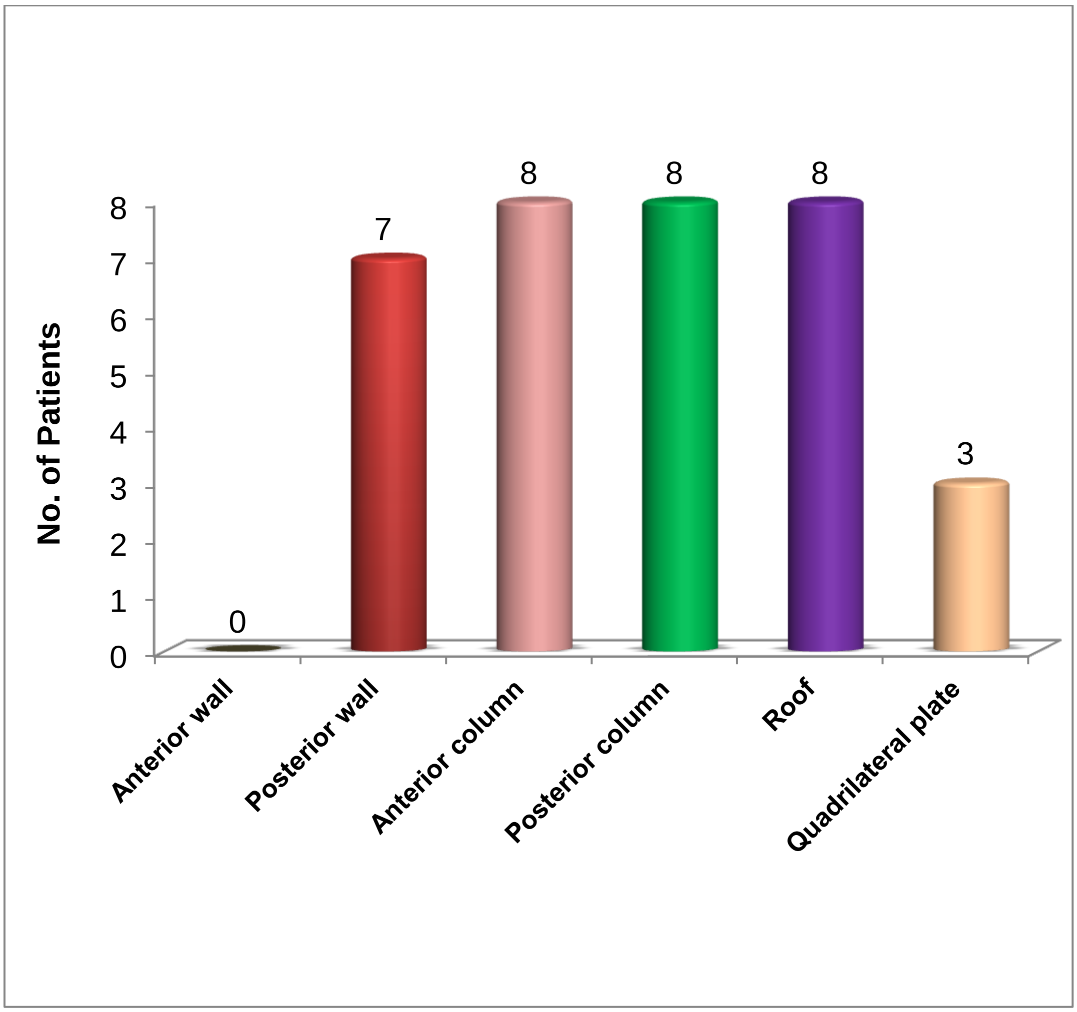

Figure 4:- Distribution Of Acetabulum Fractures On Pelvic Skiagram.s

Unilateral or bilateral acetabular fractures seen on computed tomography:-

Unilateral acetabular fracture was seen in 26 patients and bilateral acetabular fracture was seen in three patients on CT while on conventional radiographs it was seen in only one case.

Pattern of acetabular fractures as detected on computed tomography:-
Acetabular fractures were seen in 29 patients on CT. Out of these 29 patients, pattern of comminuted fracture was seen seen in 18 patients and 11 patients had linear pattern. In one patient, no acetabular fracture was detected on CT.

Dislocation of femoral head as detected on computed tomography:-
Out of 29 positive cases of acetabular fractures, associated dislocation of the femoral head was seenin only six cases. Most of the patients with dislocation underwent reduction of the dislocated hip prior to CT examination.

Type of dislocation of femoral head detected on computed tomography:-
Acetabular fractures were associated with dislocation of the femoral head in six cases. Out of these, posterior dislocation of the femoral head was seen in four cases, central dislocation in two case whereas none of the case had anterior dislocation.

Distribution of acetabular fractures on computed tomography:-
Most commonly involved segment of the acetabulum on CT was roof seen in 18 cases (62%) and quadrilateral plate seen in 12 cases (41.4%). Involvement of the posterior wall , anterior wall, anterior and posterior column was seen in 9 cases (31%). Fracture involving the anterior wall was seen in 3 patients (10.3%).

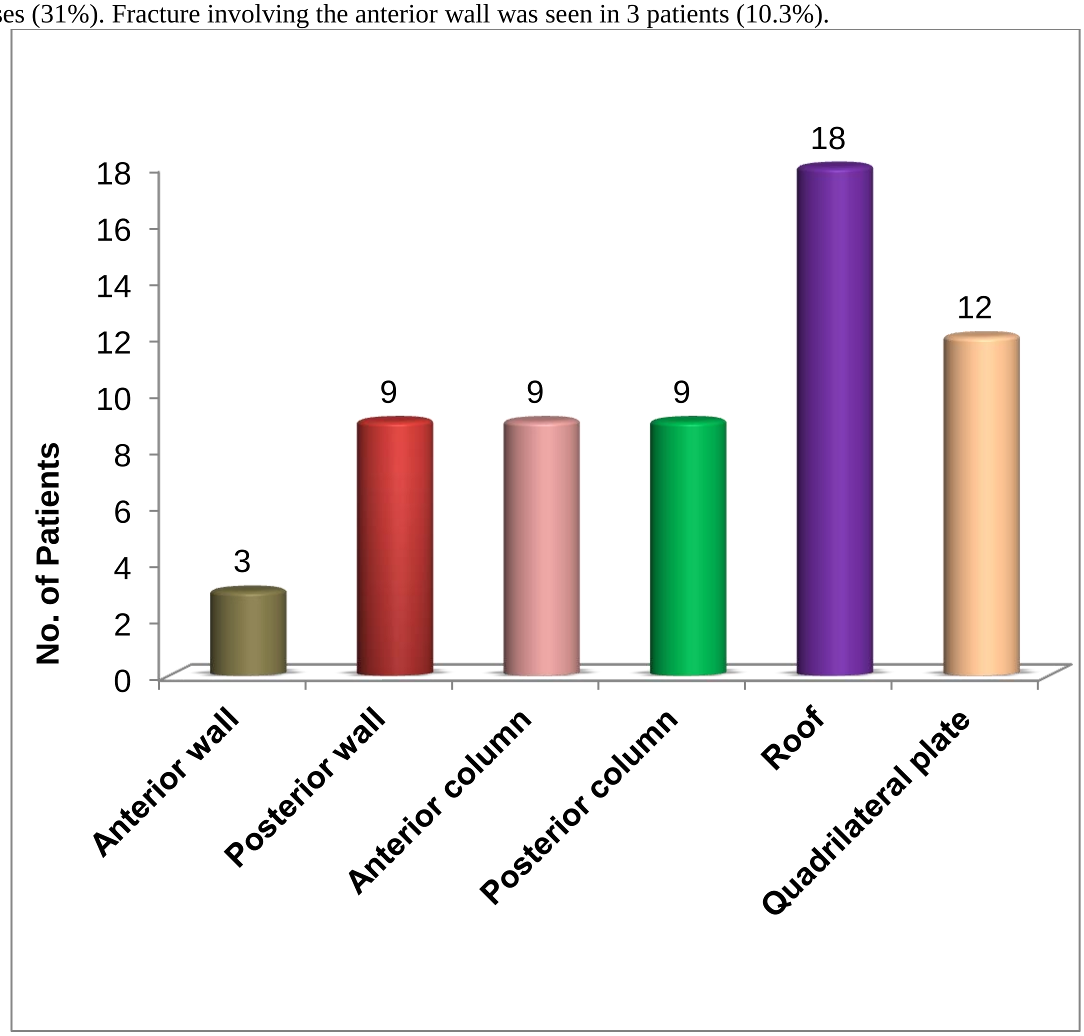

Figure 5:- Distribution Of Acetabular Fractures On Computed Tomography.

Associated fractures of pelvic bones seen on computed tomography:-

Along with acetabular fractures, the fractures of the pelvic bones were detected. Fractures involving the pubic bone were seen in 14 cases (27.5%), fracture of sacrum was seen in 5 cases (17.2%) and fracture of femoral head was seen in o3
Cases(10.3%)

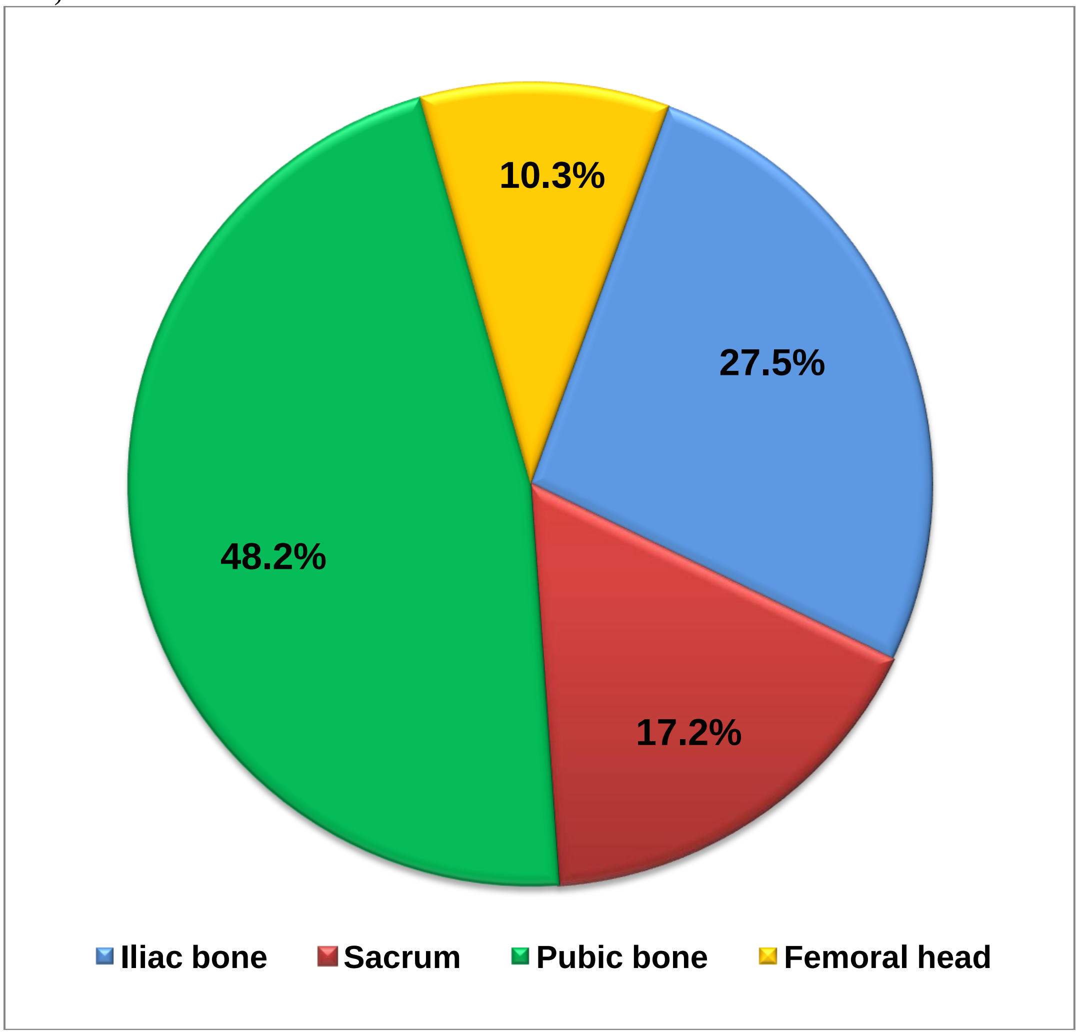

Figure 6:- Associated Fractures Of Pelvic Bones Seen On Computed Tomography (N=29)

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Combination of pelvic fractures as detected on computed tomography:-

In some patients, more than one segment of acetabulum was fractured. The most common combination was seen in fracture of roof and quadrilateral plate of acetabulum seen in 7 cases (24%), next common combination was fracture involving both columns (13.7%).

Number of intra-articular bony fragments detected on computed tomography:-

Intra-articular bony fragments were seen in 7 (24%) of patients on CT. Single bony fragment was seen in 4 cases (57%) . Multiple bony fragments were seen in 3
Cases(43%).

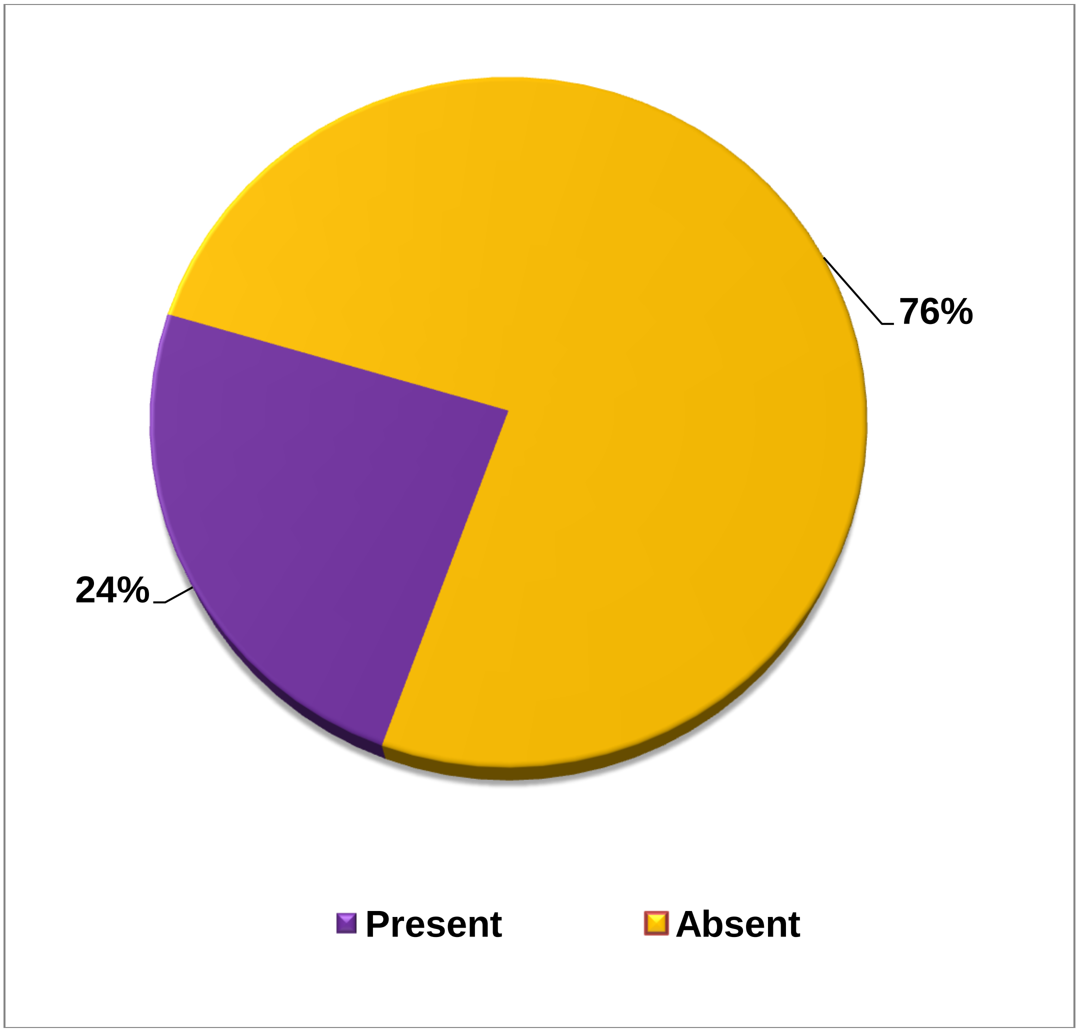

Figure 7:- Intra-Articular Bony Fragments Detected On Computed Tomography.

Discussion:-

In our study, the maximum number of patients were in the age group of 20-40 years (60%) with mean age of 36.26 yrs and median age of 30. This reflects the most active age in life, especially with regard to travelling. Our results were comparable with those of Adam et al (4). In their study of thirty patients, the age of patients ranged from 17-73 yrs with mean age of 34.5 yrs.

Roadside injury due to motor vehicle injury was the leading cause of pelvic trauma in 28 patients (93.3%), whereas fall from height accounted for 2 patients (6.6%). High incidence of pelvic trauma (93.3%) caused by motor vehicle accidents is comparable to the study of Snohiadski et al (13) who reported traffic accidents as a cause of acetabular fractures in 84% of patients.

CT is superior to plain radiography in not only confirming or excluding the fractures but also clearly demonstrating whether the fractures are unilateral or bilateral. Bilateral involvement of acetabulum on conventional radiography was noted only in one case while on CT, bilateral involvement was seen in 3 patients. There were two cases where bilateral involvement was missed on X-ray.

Hip dislocation was detected in 14 patients (46.6%) on radiography whereas it was seen in only 6 cases (20%) on CT examination. This discrepancy could be attributed to the fact that most of these patients were subjected to CT examination after post reduction of the dislocated hip. The incidence of dislocation of femoral head associated with acetabular fracture in our study was comparable to that of Sauser et al (11). In their study 53% of patients had associated dislocation of femoral head as compared to 46.6% in our study. High incidence of posterior dislocation (78.5%) in the present study was comparable to that of Brown et al (12) who also reported 14 patients of posterior dislocation out of 17 patients included in their study.

According to Harley et al (6), the sensitivity of CT is more in detection of fractures of quadrilateral plate and roof as transverse axis of the CT images allows the precise characterization of the abnormality of this structure, which is not possible with conventional radiography. In their study of 26 patients of pelvic trauma, the authors reported 100% sensitivity of CT in detecting fractures of roof and quadrilateral plate compared to 73% for conventional radiography. The overall sensitivity of X-ray in detection of acetabular fractures was 26/29 (89%) and overall sensitivity of CT was 100%. Authors also observed that there was no significant difference between plain radiography and CT in detecting fractures of anterior column, posterior column and posterior wall. This can be attributed to the fact that these structures are so oriented that are quite well seen on conventional radiography. We also found almost equal sensitivity of CT and conventional radiography in detecting fractures of anterior column (89%), posterior column (89%) and posterior wall (78%) on conventional radiography and 100% on CT for all the segments of acetabulum. Martinez et al (1) also illustrated the above fact in their study.

Sensitivity of CT in detecting intra-articular fragments in present study compares well with the other authors. The intra-articular fragments were detected on CT in 7 patients, while on conventional radiography of pelvis, intra-articular fragments were not seen in even a single patient. Harley et al (6) detected intra-articular bony fragments in 18 out of 26 patients with acetabular fractures, whereas plain radiography showed no intra-articular bony fragment. Sauser et al(11) did not detect any bony fragment on plain skiagrams as compared to CT in which bony fragments were seen

In 3 patients. Adab et al (4) also emphasized superiority of CT in detection of any intra-articular bony fragment as compared to conventional radiography as they detected one or more loose bodies in 33% of patients included in their study whereas only one loose body was apparent on conventional radiography.

The use of 3D surface reformations of complex anatomical structures from sets of contiguous axial CT sections had been discussed by Guy et al (7), Magid et al (17),Fishman et al(15) and Rommense et al (16). Guy et al(7) observed that fracture lines demonstrated on plain radiographs and axial scans are not always apparent on 3D reconstructions, hence according to authors, 3D is complementary and not a substitute to good quality plain radiographs and axial computed tomographic sections. In our study, all the axial sections of CT scan were superior to the reconstructed images in the detection of acetabular fractures. 3DCT did not alter the initial radiological diagnosis but it did provide the best and most easy interpretation of overall assessment of the fractures.

The comparison between CT and plain radiography shows that CT is more sensitive than conventional radiography in detecting linear, undisplaced fractures of acetabulum, detecting fractures involving quadrilateral plate and acetabular roof. In addition, abnormalities of the hip joint space like loose bony fragments were detected more often on CT. Hence CT has been advocated as an adjuvant to conventional radiography in the evaluation of acetabular fractures of the pelvic bones.

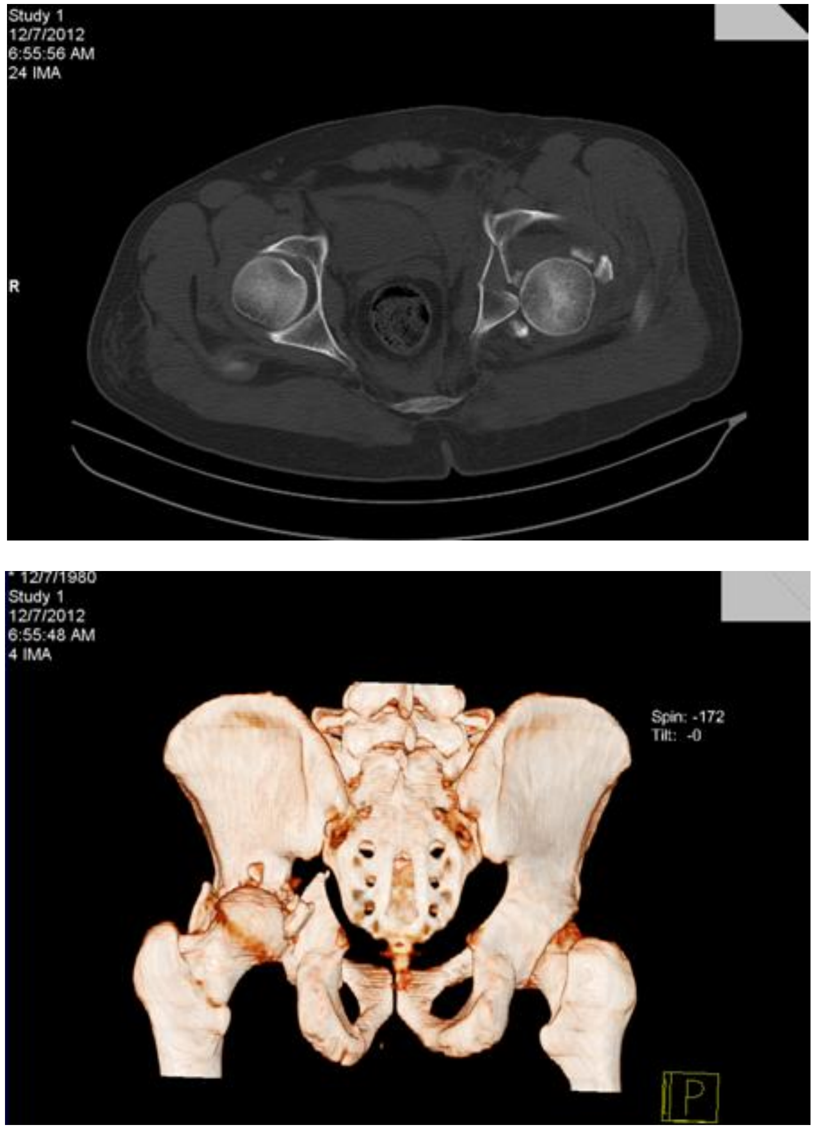

Figure 8:- Axial and 3D Reformated CT images showing T shaped fracture of Left Acetabulum with Posterior Dislocation of Left Femur.

Figure 9:- Coronal and axial CT images showing Comminuted fracture of both the coloumns extending superiorly to involve iliac bone on left side.

Figure 10:- Axial CT images showing Fractures of Posterior wall and Posterior column of Left Acetabulum.

Figure 11:- Coronal and 3D CT images showing comminuted fracture of both columns of right acetabulum with extension into iliac bone.

Figure 12:- X ray showing disruption of iliopectineal line and fracture of both superior and inferior pubic rami.

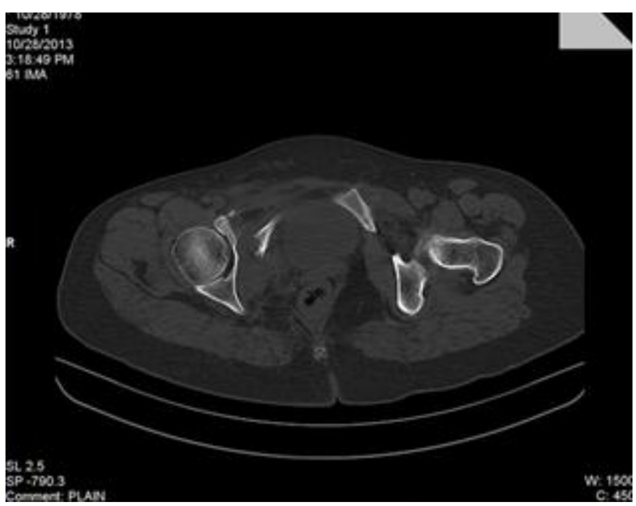

Figure 13:- Axial and 3D Reformatted CT images showing Fracture of Anterior wall and Anterior Column of Right Acetabulum.

Summary and Conclusion:-

The radiological evaluation of hip and acetabulum has been revolutionized by development of computed tomography because of its fine definition of sectional anatomy and accurate assessment of pelvic trauma. CT is superior to plain radiography in not only confirming or excluding the fractures but also clearly demonstrate whether the fractures are unilateral or bilateral.The overall sensitivity of X-ray in detection of acetabular fractures is 86% (26/29) and overall sensitivity of CT is 100%. From the present study, we conclude that computed tomography is superior to conventional radiography in detecting acetabular fractures, involvement of specific segment of acetabulum, associated fractures of pelvic bones and in detection of intra-articular fragments. CT displays the better anatomy of acetabulum in axial plane, thereby providing the missing pieces of information and greatly facilitating the classification of acetabular injury.

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